out his deductions. There is but one thing lacking, and that is the devotion of any special chapter to those diseases of the ear—notably the condition known as middle ear sclerosis—acknowledged to be hereditary, or to the diseases of the throat and nose which are predisposing causes of deficient hearing power. Considering the large percentage of all forms of nasal obstruction existing in the condition of civilisation—a percentage larger, we believe, in America than in Europe—it would be of interest to investigate the influences diseases of the throat and nose exercise upon the marriages of persons suffering therefrom.

In spite of the fact that statistics are always somewhat dry, and the deductions given from those in Mr. Fay's work are put without useless verbiage, the book is a very readable one to those interested in all branches of the subject, and should rank high as a work of reference.

MACLEOD YEARSLEY.

THE LIQUEFACTION OF GASES.

The Rise and Development of the Liquefaction of Gases. By Willett L. Hardin, Ph.D. Pp. viii+250. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1899.)

La Liquéfaction des Gaz et ses Applications. By Prof. Julien Lefèvre. Pp. 175. (Paris: Gauthier-Villars et Fils, and Masson et Cie.)

A BOOK should be criticised with reference to the author's professed object in writing it. Dr. Hardin professes to have written for the popular reader, in the popular science style. Regarded from this point of view the work deserves a good deal of praise. It is, in the first place, interesting to read, collecting, as it does, a great many facts connected with the development of low-temperature research, and detailing numerous experiments which are explained with the assistance of copious and clear illustrations. It may therefore be recommended, with the reservations which are made below, to those who, with a very elementary knowledge of physics, desire to learn something of the details of recent progress in a very interesting subject. The recommendation should be all the heartier because the author's style is free from the patriotic brag and boom which disfigure another recent American book on the same subject, and because the right side is taken as to the marvellous industrial revolutions heralded from America as a consequence of later work in this department of science. A further merit in the work is the abundance of exact references to original authorities, for the benefit, as stated in the preface, of those who wish for fuller information.

The fact, however, that the author had the latter object in view emphasises what should be a binding obligation even in books intended solely for popular reading, namely, to take care that such science as is introduced shall be strictly correct; and this obligation Dr. Hardin has fallen short of in a serious degree. On pp. 183–185 he reproduces Edwin J. Houston's suggestions for an apparatus to produce intense refrigeration. The nearest thing to a novelty in these suggestions is the proposal to modify Windhausen's machine by substituting a two-stage compressor for a single-stage one, and so obtaining a higher pressure of sixty atmospheres. He expressly retains Windhausen's system of power expansion in a cylinder doing work on a piston; yet Dr. Hardin says:

> "In the apparatus suggested, Houston anticipated the methods which were employed twenty years later in the liquefaction of air by Linde, Hampson and Tripler."

This is inexcusable in one who undertakes to "enable the popular reader to understand the principles involved." The same confusion is repeated much more deliberately later on. On pp. 205–208 the author works out mathematically the formula for the cooling produced by power expansion, $\left(\frac{p}{p_1}\right)^{\frac{k-1}{k}} = \frac{T}{T_1}$, which he calls equation (7). He then says:

> "Applying these results to the liquefaction of gases by means of the regenerative coil, it is evident that the expansion of the gas in the tube lowers the temperature by an amount which corresponds to equation (7)."

The formula for power expansion is here applied where we ought to have had Thomson's formula for free expansion, $-\frac{d\theta}{dp} = A\left(\frac{273{\cdot}7}{t}\right)^2$. The title of the section is "Theory of the Self-intensification Method of Refrigeration," and a note, at the foot of the same page, refers us to Joule and Thomson for a more complete discussion, which, however, in the body of the section, instead of being abridged or summarised, is altogether replaced by another analysis. The way in which the book is written gives no reason to suppose that Dr. Hardin is incapable of distinguishing between the very different conditions involved in power-expansion and free expansion, or the very different mathematical analyses appropriate to these two sets of conditions. The only tolerable explanation of such a gross confusion is that it has never come in Dr. Hardin's way to read Thomson's papers on the cooling of gases by free expansion, or to examine intimately the nature of the phenomena involved, and so he has carelessly applied to these phenomena the well-known formula for cooling by power-expansion. This is not the proper way to write a book even for the satisfaction of the interest of the popular reader. These are not the only instances that the author shows of a lack of thorough acquaintance with his subject. If he had studied Mr. Tripler's British patent of 1893, which is put forth as the foundation of his claims as inventor of a form of self-intensive air-liquefier, and had paid attention to the chronology of the subject, Dr. Hardin would perhaps not have felt justified in treating those claims so well as he has done, by describing those parts of Mr. Tripler's apparatus which are not kept secret. On p. 227, the author gives Prof. Dewar's conclusion, that the liquefying points of hydrogen and helium are near together, without giving the subsequent correction.

The style of the writing is occasionally careless and slipshod, and the meaning sometimes undiscoverable. On p. 209 we are told

> "the issuing jet experiences a much greater decrease in temperature owing to the greater difference between the initial and final pressures."

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This is unintelligible in view of the fact that the difference between the initial and final pressures does not increase, while in case of supply from a cylinder of compressed gas, it actually decreases. On p. 232 we find the sentence: "Below the temperature of zero degrees ice slowly sublimes." Some misprints have escaped correction. On p. 208 the minus sign is omitted between k and 1 in equation (7). On p. 243 the second "i" in the name Lavoisier has been omitted.

If in a new edition such mistakes be corrected, and the latter part of Chapter iv., Section 3, be rewritten, the book will be useful as well as interesting to the class of readers for whom it is chiefly intended.

Prof. Lefèvre's book is very well written and clearly illustrated. Within the narrow limits of 175 pages it contains a considerable amount of correct theory, a very interesting history of the experimental development of gas-liquefaction, some discussion of industrial applications, and a very full list of references to original authorities; and all this with a surprising freedom from the evils of over-compression. The arrangement is not altogether perfect. Prof. Dewar's apparatus figured on pp. 55 and 61 apply the combination of free expansion with counter-current interchange, a method of which there was earlier authenticated invention both in England and Germany. These applications should have been described in Section 35 under the head "Machines à détente sans travail extérieur," and after the invention on which they depend; or, if it was thought advisable to discuss them out of chronological order, their dependence on the combination in that invention should have been clearly brought out. The illustration of Mr. Tripler's apparatus on p. 84 might well have been omitted. The employment of three-stage compressors, with cooling coils between the stages, with purifiers, water-separators, and pressure-gauge, was familiar to pneumatic engineers for years before they were employed by Mr. Tripler in liquefying air; and the vitally important interchanger and expansion valve remain such a mystery that the illustration gives no idea what they are like or whether they differ essentially from the invention of Dr. Linde and Dr. Hampson. On p. 70 the statement that helium was liquefied at the temperature of boiling hydrogen needs correcting in accordance with later results. Chapter ix., on modern commercial refrigerating machines, is very much out of proportion with the rest of the book; a discussion of this subject, which entirely passes by the great American and British developments in this field, might as well be omitted altogether.

A CONTRIBUTION TO ZOO-GEOGRAPHY.

Studien zur Geographie. Von Dr. W. Kobelt. Zweiter Band. Pp. x + 369. (Wiesbaden: Kreidel, 1898.)

IN this, the second part of his "studies," Dr. Kobelt deals at full length with the characteristics of the fauna and to some extent also, of the flora of the "Meridional Sub-region." This region very nearly corresponds to the Mediterranean sub-region of Dr. Wallace; its northern limits are a trifle more extensive, embracing as they do the Crimea and Bessarabia.

As might be expected from the nature of his own zoological studies, the author lays most stress upon the distribution of Mollusca, and gives a series of elaborate and apparently very full tables of species found in the different departments into which he divides the region described in this volume. It must not, however, be inferred from this that other groups of animals are neglected or even treated with indifference.

A great deal is said about the range of the vertebrata of this part of the world in the past as well as in the present, all the orders of that assemblage of animals being taken into consideration. There is one group of terrestrial, aquatic and semi-aquatic invertebrates which are not at all discussed by Dr. Kobelt. This group—that of the earthworms and their allies—might profitably have been dealt with, inasmuch as their range, so far as is known, marks out very well not only the limits of the Palæarctic region (excluding only Japan), but also enables a line to be drawn between the more northern and the Mediterranean portions of the region dealt with by Dr. Kobelt. Inasmuch as a large portion of the meridional region is occupied by the Mediterranean sea, the author is, we think, wise in paying some attention to the fauna of that sea, as well as of other stretches of water included within his area. A special chapter is devoted to the Mediterranean, and the author commences by addressing himself to the problem as to whether that inland sea is really an independent tract or a section of the Atlantic.

The colossal faunistic and structural monographs issued by the Naples Zoological Station, as well as the results of elaborate studies carried on at similar institutions along the coasts of the Mediterranean, have made us well acquainted with the shallow water fauna of that sea. We are less informed as to the pelagic creatures, especially mammals, and about the deep-sea fauna. As to the former, observes the author, "the mammalogist will, with a regretful shrug of the shoulders, confess himself incompetent" to speak with accuracy. So far as we know, the whales are not special to that sea; nor does palæontological evidence hint at the Mediterranean as a centre of origin. Oliver Goldsmith, in his "Animated Nature," pointed out that the Mediterranean dolphin occurred in the Red Sea. He was doubtless right, though the reasoning employed may have been defective, and there is no prevision of the Suez Canal! The sperm whale is found therein, and (if we may regard the sea beast from which Perseus delivered Andromeda as a "monstrous physetere"!) was even known to the ancients. Pliny's Orca was, it appears, rather that "sea should'ring whale" than a gladiator. The dolphin of the Mediterranean has received many names, but there seems to be little doubt that that whale of Greek coins is exactly the same as the dolphin of the coasts of the Atlantic. "As concerns mammals," concludes Dr. Kobelt, "the Mediterranean is an impoverished gulf of the Atlantic Ocean."

In the characteristics of the Mollusca found, and some other animals, the Mediterranean presents tropical characters which are, partly at least, in reality due to the Suez Canal. Mr. E. A. Smith, of the Natural History Museum, contributed some years since a number of interesting facts to the Zoological Society bearing upon such immigrations. The Mediterranean, as is well known, sinks in places to profoundly abyssal depths; the actually greatest depth appears to be 4400 metres; but

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